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ENGINEERING DESIGN FILE

Project/Task ISV Summary Characterization of the SDA
Subtask Metal Content of Waste Buried in the SDA

Subject : ESTIMATE OF METAL CONTENT OF SDA

Abstract :

An estimate of the metal content of TRU contaminated wastes at the Subsurface Disposal Area (SDA) is necessary to determine the feasibility of in situ vitrification (ISV) for these wastes. The SDA areas evaluated were pits 1-6, 9, 10, and trenches 1-10.

Pit 9 was evaluated most extensively using dBASE III. The metal weight and metal composition were calculated for Pit 9 by analyzing the content codes and the origin of the wastes. The average weight percent of metal for Pit 9 is estimated for a worst case scenario to be 4.0%.

A less intensive evaluation of metal content was made for the other pits and trenches. An assumption was used to find the maximum and minimum weight percent metal that might be present in these pits and trenches. The assumed percent metal was multiplied by the waste mass to arrive at the mass of metal. After finding the amount of metal that might be present, the metal composition calculated for Pit 9 was then used to estimate the composition of the metal. The weight percent metal was then calculated for each pit and trench. The mass of metal was found to range from 1.7 to 11.6 wt% for the worst case scenario used in the analysis.

The assumptions and methodology used in the analysis for the metal content of the waste buried in the SDA are explained in the next sections. This EDF will be modified as more information becomes available.

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Metal Content For Pit 9:

The waste buried in Pit 9 is described by using content codes. Each content code only provides a generalized statement of the waste. An example is content code 006, which states "Concrete Masonry". Based upon the descriptions given, educated estimates of the metal mass percentage were made for each code. Fifteen of the 25 content codes used for Pit 9 were determined to contain most of the metal buried in Pit 9. The other codes either were assumed to contain little or no metal and any metal found in these codes would be accounted for in the overall estimated weights. Six of the codes, based on the descriptions, were estimated to consist of all metal. Table 1 summarizes the assumptions made regarding the metal weight percent of each code used in Pit 9.

The containers used in some codes were metal drums. A weight of 22.7 kg (50 lb) was estimated for each metal drum. The weight for the drums was calculated and this weight was then subtracted from the total weight to give the weight of the contents. The content weight was then used to estimate the metal weight given the assumptions summarized in Table 1.

The type of metal contained in the waste was estimated by looking at the waste description of each code. For example, piping (content code 024) was assumed to be 75% stainless steel (SS) since the majority of piping used in nuclear facilities is of this material. The assumptions used for the metal composition of each code are listed in Table 1.

Table 2 summarizes the estimated metal content in this pit. With the above assumptions, the total metal weight is estimated at 665,655 kg. The entire mass for the waste disposed in Pit 9 was found from RWMIS to be 1,355,707 kg. Forty nine percent of the waste buried in Pit 9 is metal. Table 3 gives the estimated composition of the metals buried in Pit 9. It

was calculated that there is 326,502 kg of carbon steel (49.1% of the buried metal) and 309,694 kg of stainless steel (46.5% of the buried metal). The remaining 4.4% of the metal is assumed to be composed of aluminum, iron, lead, and zirconium.

Table 1. METAL PERCENTAGE AND COMPOSITION FOR PIT 9 WASTE

CODE	WEIGHT PERCENT	ESTIMATED COMPOSITION [a]
002	DRUMS	CS (100)
003	DRUMS	CS (100)
	65	SS (50), CS (50)
004	DRUMS	CS (100)
	65	SS (100)
010	75	SS (75), CS (15), AL (10)
024	100	SS (75), CS (25)
027	100	SS (75), CS (25)
030	100	SS (85), AL (15)
032	100	PB (100)
035	5	SS (100)
040	100	ZIRCONIUM (100)
043	5	SS (100)
066	65	SS (50), CS (50)
088	100	SS (50), CS (50)
092	85	FE (40), PB (60)
093	DRUMS	CS (100)
	5	SS (100)

AL: Aluminum
CS: Carbon Steel
FE: Iron
PB: Lead
SS: Stainless Steel
a. Figures in parenthesis represent weight percentage of this type of metal.

Table 2. ESTIMATE OF METAL CONTENT IN PIT 9

Code	Total Waste Weight (kg)	Percent Metal Of Waste	Quantity Of Drums	Drum Metal Weight (kg)	Waste Metal Weight (kg)	Total Metal Weight (kg)	Nonmetal Weight (kg)
002	276691.58	0	2106	47806.2	0.0	47806.2	228885.4
003	155761.14	65	1512	34322.4	78935.2	113257.6	42503.6
004	18099.23	65	303	6878.1	7293.7	14171.8	3927.4
010	23908.35	75	0	0.0	17931.3	17931.3	5977.1
024	18596.46	100	0	0.0	18596.4	18596.5	0.0
027	126598.82	100	0	0.0	126598.8	126598.8	0.0
030	3628.43	100	0	0.0	3628.4	3628.4	0.0
032	3030.13	100	0	0.0	3030.1	3030.1	0.0
035	5165.02	5	0	0.0	258.2	258.3	4906.8
040	17420.03	100	0	0.0	17420.0	17420.0	0.0
043	886.43	5	0	0.0	44.3	44.3	842.1
066	387312.35	65	0	0.0	251753.0	251753.0	135559.3
088	5625.09	100	0	0.0	5625.0	5625.1	0.0
092	7849.50	85	0	0.0	6672.0	6672.1	1177.4
093	200586.23	5	1337	30349.9	8511.8	38861.7	161724.5
		TOTAL:	5258	119356.6	546298.6	665655.2	585503.6

Table 3. ESTIMATED METAL COMPOSITION IN PIT 9

CODE	Percentage Metal						CS[a] Weight (kg)	SS Weight (kg)	AL Weight (kg)	FE Weight (kg)	PB Weight (kg)	ZR Weight (kg)
	% CS	% SS	% AL	% FE	% PB	% ZR						
002	0	0	0	0	0	0	47806.2	0.0	0.0	0.0	0.0	0.0
003	50	50	0	0	0	0	73790.0	39467.6	0.0	0.0	0.0	0.0
004	0	100	0	0	0	0	6878.1	7293.7	0.0	0.0	0.0	0.0
010	15	75	10	0	0	0	2689.7	13448.4	1793.1	0.0	0.0	0.0
024	25	75	0	0	0	0	4649.1	13947.3	0.0	0.0	0.0	0.0
027	25	75	0	0	0	0	31649.7	94949.1	0.0	0.0	0.0	0.0
030	0	85	15	0	0	0	0.0	3084.2	544.3	0.0	0.0	0.0
032	0	0	0	0	100	0	0.0	0.0	0.0	0.0	3030.1	0.0
035	0	100	0	0	0	0	0.0	258.3	0.0	0.0	0.0	0.0
040	0	0	0	0	0	100	0.0	0.0	0.0	0.0	0.0	17420.0
043	0	100	0	0	0	0	0.0	44.3	0.0	0.0	0.0	0.0
066	50	50	0	0	0	0	125876.5	125876.5	0.0	0.0	0.0	0.0
088	50	50	0	0	0	0	2812.5	2812.5	0.0	0.0	0.0	0.0
092	0	0	0	40	60	0	0.0	0.0	0.0	2668.8	4003.2	0.0
093	0	100	0	0	0	0	30349.9	8511.8	0.0	0.0	0.0	0.0
						TOTAL:	326501.8	309693.8	2337.4	2668.8	7033.3	17420.0

a. The metal drums are assumed to be carbon steel. The weight of the drums is added to this column.

Metal Content for the Other Pits and Trenches:

The sums of the volumes and weights of the wastes buried in pits 1-6, 10, and trenches 1-10 were obtained from RWMIS. A less intensive evaluation will be done on these disposal areas since the data has not been transferred to dBASE III format. A preliminary study of these pits and trenches indicates that for all the trenches and for Pit 1 only one content code is used to describe the buried waste. The content code used is 007 (Radioactive Waste Not Otherwise Specified). Since it is difficult to make an educated guess of the metal weight percentage for this code, it was decided to use a simplified methodology to derive an estimate. This methodology will also be used for pits 2, 3, 4, 5, 6, and 10. When the data of these pits have been converted to dBASE III format, a similar approach as that employed for Pit 9 can be done to derive more reasonable estimates of the metal content of these disposal areas.

The methodology to be used in evaluating the metal content of these pits and trenches will use a maximum and minimum weight percent metal. For this analysis, the maximum weight percent metal will be assumed to be 80% of the total weight of the waste; while the minimum weight percent metal will be assumed to be 5%. The 80% assumption will be utilized to give a worst case scenario. It is expected that the metal weight percentage for these pits and trenches will be found to be located between the assumed upper and lower limits. In Pit 9, the metal mass percentage of the waste was estimated to be 49%.

The type of metal buried in these areas will be postulated as having the same composition as that found for Pit 9. This composition is summarized below:

Carbon Steel:	49.10%
Stainless Steel:	46.50%
Aluminum:	0.35%
Iron:	0.40%
Lead:	1.05%
Zirconium:	2.60%.

Using the maximum and minimum metal weight percentages, Table 4 summarizes the upper and lower weight estimates for all of the pits and trenches. Tables 5 and 6 show the estimated metal composition for both the maximum and minimum scenarios. The estimated maximum weight of metal for all of the trenches and pits is 22,370,320 kg; while the minimum weight is estimated to be 1,398,145 kg. The metal weight for Pit 9 is not included in these tables.

Table 4. ESTIMATE OF METAL CONTENT IN THE SDA

Waste Location	Total Weight (kg)	Maximum Metal Weight (kg)	Minimum Metal Weight (kg)
PIT 1	337,300	269,840	16,865
PIT 2	7,264,000	5,811,200	363,200
PIT 3	823,500	658,800	41,175
PIT 4	5,539,000	4,431,200	276,950
PIT 5	2,968,000	2,374,400	148,400
PIT 6	2,672,000	2,137,600	133,600
PIT 10	6,148,000	4,918,400	307,400
TRENCH 1	274,500	219,600	13,725
TRENCH 2	123,700	98,960	6,185
TRENCH 3	196,500	157,200	9,825
TRENCH 4	267,600	214,080	13,380
TRENCH 5	347,200	277,760	17,360
TRENCH 6	305,000	244,000	15,250
TRENCH 7	198,800	159,040	9,940
TRENCH 8	208,000	166,400	10,400
TRENCH 9	179,300	143,440	8,965
TRENCH 10	110,500	88,400	5,525
TOTAL:	27,962,900	22,370,320	1,398,145

Table 5. MAXIMUM ESTIMATED METAL COMPOSITION IN THE SDA

Waste Location	Maximum Metal Weight (kg)	CS Weight (kg)	SS Weight (kg)	AL Weight (kg)	FE Weight (kg)	PB Weight (kg)	ZR Weight (kg)
PIT 1	269,840	132,491	125,476	944	1,079	2,833	7,016
PIT 2	5,811,200	2,853,299	2,702,208	20,339	23,245	61,018	151,091
PIT 3	658,800	323,471	306,342	2,306	2,635	6,917	17,129
PIT 4	4,431,200	2,175,719	2,060,508	15,509	17,725	46,528	115,211
PIT 5	2,374,400	1,165,830	1,104,096	8,310	9,498	24,931	61,734
PIT 6	2,137,600	1,049,562	993,984	7,482	8,550	22,445	55,578
PIT 10	4,918,400	2,414,934	2,287,056	17,214	19,674	51,643	127,878
TRENCH 1	219,600	107,824	102,114	769	878	2,306	5,710
TRENCH 2	98,960	48,589	46,016	346	396	1,039	2,573
TRENCH 3	157,200	77,185	73,098	550	629	1,651	4,087
TRENCH 4	214,080	105,113	99,547	749	856	2,248	5,566
TRENCH 5	277,760	136,380	129,158	972	1,111	2,916	7,222
TRENCH 6	244,000	119,804	113,460	854	976	2,562	6,344
TRENCH 7	159,040	78,089	73,954	557	636	1,670	4,135
TRENCH 8	166,400	81,702	77,376	582	666	1,747	4,326
TRENCH 9	143,440	70,429	66,700	502	574	1,506	3,729
TRENCH 10	88,400	43,404	41,106	309	354	928	2,298
TOTAL:	22,370,320	10,983,827	10,402,199	78,296	89,481	234,888	581,628

Table 6. MINIMUM ESTIMATED METAL COMPOSITION IN THE SDA

Waste Location	Minimum Metal Weight (kg)	CS Weight (kg)	SS Weight (kg)	AL Weight (kg)	FE Weight (kg)	PB Weight (kg)	ZR Weight (kg)
PIT 1	16,865	8,281	7,842	59	67	177	438
PIT 2	363,200	178,331	168,888	1,271	1,453	3,814	9,443
PIT 3	41,175	20,217	19,146	144	165	432	1,071
PIT 4	276,950	135,982	128,782	969	1,108	2,908	7,201
PIT 5	148,400	72,864	69,006	519	594	1,558	3,858
PIT 6	133,600	65,598	62,124	468	534	1,403	3,474
PIT 10	307,400	150,933	142,941	1,076	1,230	3,228	7,992
TRENCH 1	13,725	6,739	6,382	48	55	144	357
TRENCH 2	6,185	3,037	2,876	22	25	65	161
TRENCH 3	9,825	4,824	4,569	34	39	103	255
TRENCH 4	13,380	6,570	6,222	47	54	140	348
TRENCH 5	17,360	8,524	8,072	61	69	182	451
TRENCH 6	15,250	7,488	7,091	53	61	160	397
TRENCH 7	9,940	4,881	4,622	35	40	104	258
TRENCH 8	10,400	5,106	4,836	36	42	109	270
TRENCH 9	8,965	4,402	4,169	31	36	94	233
TRENCH 10	5,525	2,713	2,569	19	22	58	144
TOTAL:	1,398,145	686,489	650,137	4,894	5,593	14,681	36,352

Metal Fraction of the Pits and Trenches:

In this section, the maximum metal mass found for each pit and trench in Table 4 will be used to determine the weight percent metal buried in the individual pit or trench. Using the maximum metal calculated enables us to determine the worst case scenario. For Pit 9, the estimated metal weight found in the previous section will be used instead of the assumed 80 weight percent metal. A general analysis will be done on all the pits and trenches. In this analysis, the waste will be assumed to be evenly distributed along the burial area. A more detailed analysis will be done on Pit 9 in the following section to determine the validity of this assumption.

Reference 2 will be used to determine the volume of soil to be vitrified. The volume of a pit or trench is shown as consisting of the excavated and the overburden volumes. The excavated volume is the actual volume of the pit or trench. In this case, the excavated volume was calculated in this reference by finding the depth of the trench or pit and multiplying by the surface area of the pit or trench. The depth is the distance from the original grade (surface) to the basalt layer. The overburden is the soil added on top of the original surface. The overburden is almost the same depth as the excavated portion for several pits.

For this analysis, two cases will be studied to derive the metal weight percentage of the buried waste. In the first case, both the excavated and overburden soil are included in the calculations. This will necessarily result in a lower metal weight percent since a large mass of clean soil is included in the calculations. In the second case, only the excavated soil will be considered. The actual volume of soil that is used is calculated by subtracting the waste volume from the excavated and overburden volume in Case 1 or from the excavated volume in Case 2. A density of 42.48 kg/ft^3 (1500 kg/m^3) is used to determine the mass of the soil . This density was derived from Reference 3 which analyzed the SDA soil. The analysis of this soil yielded a specific gravity of 1.5 which is equal to

Table 7. VOLUME AND MASS FOR EXCAVATED/OVERBURDEN SOIL (CASE 1)

Waste Location	Waste Volume (ft3)	Excavated & Overburden Vol. (ft3)	Total Soil Volume (ft3)	Total Soil Weight (kg)
CALCULATION:	A	B	C = B - A	C x 42.48
PIT 1	82,166	616,480	534,314	22,697,659
PIT 2	421,248	2,179,408	1,758,160	74,686,637
PIT 3	102,045	708,450	606,405	25,760,084
PIT 4	388,410	1,994,601	1,606,191	68,230,994
PIT 5	286,680	1,272,088	985,408	41,860,132
PIT 6	223,865	1,036,925	813,060	34,538,789
PIT 9	150,668	727,634	576,966	24,509,516
PIT 10	538,830	2,352,315	1,813,485	77,036,843
TRENCH 1	16,895	117,583	100,688	4,277,226
TRENCH 2	6,800	164,196	157,396	6,686,182
TRENCH 3	15,928	165,316	149,388	6,346,002
TRENCH 4	17,789	166,212	148,423	6,305,009
TRENCH 5	18,174	106,523	88,349	3,753,066
TRENCH 6	15,473	165,988	150,515	6,393,877
TRENCH 7	11,132	106,173	95,041	4,037,342
TRENCH 8	16,416	166,212	149,796	6,363,334
TRENCH 9	13,534	105,473	91,939	3,905,569
TRENCH 10	9,290	165,652	156,362	6,642,258
TOTAL:	2,335,343	12,317,229	9,981,886	424,030,517

Table 8. VOLUME AND MASS FOR EXCAVATED SOIL (CASE 2)

Waste Location	Waste Volume (ft3)	Excavated Volume (ft3)	Total Soil Volume (ft3)	Total Soil Weight (kg)
CALCULATION:	A	B	C = B - A	C x 42.48
PIT 1	82,166	431,536	349,370	14,841,238
PIT 2	421,248	1,684,088	1,262,840	53,645,443
PIT 3	102,045	472,300	370,255	15,728,432
PIT 4	388,410	1,154,769	766,359	32,554,930
PIT 5	286,680	803,424	516,744	21,951,285
PIT 6	223,865	600,325	376,460	15,992,021
PIT 9	150,668	513,624	362,956	15,418,371
PIT 10	538,830	1,456,195	917,365	38,969,665
TRENCH 1	16,895	81,270	64,375	2,734,650
TRENCH 2	6,800	124,768	117,968	5,011,281
TRENCH 3	15,928	125,888	109,960	4,671,101
TRENCH 4	17,789	126,784	108,995	4,630,108
TRENCH 5	18,174	70,210	52,036	2,210,489
TRENCH 6	15,473	126,560	111,087	4,718,976
TRENCH 7	11,132	69,860	58,728	2,494,765
TRENCH 8	16,416	126,784	110,368	4,688,433
TRENCH 9	13,534	69,160	55,626	2,362,992
TRENCH 10	9,290	126,224	116,934	4,967,356
TOTAL:	2,335,343	8,163,769	5,828,426	247,591,536

42.48 kg/ft^3. Table 7 summarizes the volume and mass of the soil for the first case. The volume and mass of the excavated soil for Case 2 is shown in Table 8.

The metal mass percentages are calculated by adding the soil mass to the total waste mass. The metal mass is then divided by this combined soil/waste mass to derive the total metal mass percentage (wt%). Table 9 summarizes the estimated total metal mass percent that is buried in each of the pits and trenches for Case 1, in which both the excavated and overburden soil are included. For this case, the percentage ranged from 1.2 wt% in Pit 1 to 7.1 wt% in Pit 2. Table 10 summarizes the calculations for Case 2 in which only the excavated soil is included. The percentage ranged from 1.7 wt% in Trench 10 to 11.6 wt% in Pit 4. The overall average percentages were found to be 5.4 wt% for Case 1 and 8.3 wt% for Case 2.

The soil volume and mass, as determined in Tables 7 and 8, do not take into account void spaces due to backfilling inadequacies. Voids located within the waste itself are already accounted for in the waste volumes so these voids will not be considered. If a ten percent soil void space is assumed, the metal mass percentage is increased by 0.7 wt% for the maximum percentage found in Case 1 (Pit 2) to 7.8 wt% and by 1.1 wt% for the maximum percentage found in Case 2 (Pit 4) to 12.7 wt%. These void spaces will not be considered in this analysis due to the small contribution to the metal weight percentage. If the voids are found later to be a large portion, then it might be necessary to consider them; but for this analysis, it will be assumed that the soil voids are not greater than 10% of the soil volume.

Table 9. METAL WEIGHT PERCENT OF TRU CONTAINING PITS AND TRENCHES FOR CASE 1

Waste Location	Maximum Metal Weight (kg)	Buried Waste Weight (kg)	Total Soil Weight (kg)	Total Weight (kg)	Weight Percent Metal Case 1
CALCULATION:	A	B	C	D = B + C	A/D x 100
PIT 1	269,840	337,300	22,697,659	23,034,959	1.2
PIT 2	5,811,200	7,264,000	74,686,637	81,950,637	7.1
PIT3	658,800	823,500	25,760,084	26,583,584	2.5
PIT 4	4,431,200	5,539,000	68,230,994	73,769,994	6.0
PIT 5	2,374,400	2,968,000	41,860,132	44,828,132	5.3
PIT 6	2,137,600	2,672,000	34,538,789	37,210,789	5.7
PIT 9	665,655	1,355,707	24,509,516	25,865,223	2.6
PIT 10	4,918,400	6,148,000	77,036,843	83,184,843	5.9
TRENCH 1	219,600	274,500	4,277,226	4,551,726	4.8
TRENCH 2	98,960	123,700	6,686,182	6,809,882	1.5
TRENCH 3	157,200	196,500	6,346,002	6,542,502	2.4
TRENCH 4	214,080	267,600	6,305,009	6,572,609	3.3
TRENCH 5	277,760	347,200	3,753,066	4,100,266	6.8
TRENCH 6	244,000	305,000	6,393,877	6,698,877	3.6
TRENCH 7	159,040	198,800	4,037,342	4,236,142	3.8
TRENCH 8	166,400	208,000	6,363,334	6,571,334	2.5
TRENCH 9	143,440	179,300	3,905,569	4,084,869	3.5
TRENCH 10	88,400	110,500	6,642,258	6,752,758	1.3
TOTAL:	23,035,975	29,318,607	424,030,517	453,349,124	5.4

Table 10. METAL WEIGHT PERCENT OF TRU CONTAINING PITS AND TRENCHES FOR CASE 2

Waste Location	Maximum Metal Weight (kg)	Buried Waste Weight (kg)	Total Soil Weight (kg)	Total Weight (kg)	Weight Percent Metal Case 2
CALCULATION:	A	B	C	D = B + C	A/D * 100
PIT 1	269,840	337,300	14,841,238	15,178,538	1.8
PIT 2	5,811,200	7,264,000	53,645,443	60,909,443	9.5
PIT3	658,800	823,500	15,728,432	16,551,932	4.0
PIT 4	4,431,200	5,539,000	32,554,930	38,093,930	11.6
PIT 5	2,374,400	2,968,000	21,951,285	24,919,285	9.5
PIT 6	2,137,600	2,672,000	15,992,021	18,664,021	11.5
PIT 9	665,655	1,355,707	15,418,371	16,774,078	4.0
PIT 10	4,918,400	6,148,000	38,969,665	45,117,665	10.9
TRENCH 1	219,600	274,500	2,734,650	3,009,150	7.3
TRENCH 2	98,960	123,700	5,011,281	5,134,981	1.9
TRENCH 3	157,200	196,500	4,671,101	4,867,601	3.2
TRENCH 4	214,080	267,600	4,630,108	4,897,708	4.4
TRENCH 5	277,760	347,200	2,210,489	2,557,689	10.9
TRENCH 6	244,000	305,000	4,718,976	5,023,976	4.9
TRENCH 7	159,040	198,800	2,494,765	2,693,565	5.9
TRENCH 8	166,400	208,000	4,688,433	4,896,433	3.4
TRENCH 9	143,440	179,300	2,362,992	2,542,292	5.6
TRENCH 10	88,400	110,500	4,967,356	5,077,856	1.7
TOTAL:	23,035,975	29,318,607	247,591,536	276,910,143	8.3

Detailed Metal Mass Percent Analysis of Pit 9:

The low metal weight percents found in Tables 9 and 10 were primarily due to the amount of soil used to fill the trenches and pits. In order to be able to use these percentages, it will be necessary to make the assumption that the metal waste is distributed randomly throughout the pits and trenches. It is possible, however, that there will be localized areas where the metal weight percent would be higher. For example, a high concentration of metals would result if a large number of drums containing scrap metal or a large amount of piping waste have been disposed of at one time in a single area within Pit 9.

In this situation, it would be necessary to make the assumption that both the ratio of metals to soil and the amount of void area would be greater. This section then performs a more detailed analysis to determine the metal mass percentage for smaller areas of Pit 9. By this method, the variation of the weight percent for these areas from the average 4.0 wt% calculated in Table 10 is known. In this manner, one can be confident in the use of these mass percentages.

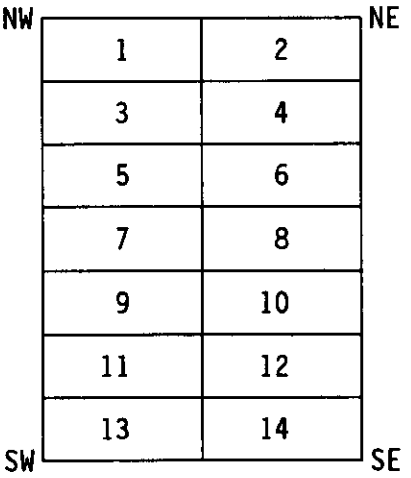
The effective metal weight percentage for each content code buried in Pit 9 is summarized in Table 11. This effective percentage was found by using the total metal weight calculated in Table 2. This total metal weight is composed of the combined weight of the estimated metal of the buried waste and the metal containers. This effective metal percent will be used in this section.

Pit 9 was divided into 14 areas. The surface dimensions for Pit 9 for this analysis was assumed to be approximately 100 ft by 350 ft. Each of the 14

Table 11. EFFECTIVE METAL PERCENTAGE FOR EACH CODE

Code	Total Waste Weight (kg)	Total Metal Weight (kg)	Effective Metal Percent
002	276691.58	47806.2	17.28
003	155761.14	113257.6	72.71
004	18099.23	14171.8	78.30
010	23908.35	17931.3	75.00
024	18596.46	18596.5	100.00
027	126598.82	126598.8	100.00
030	3628.43	3628.4	100.00
032	3030.13	3030.1	100.00
035	5165.02	258.3	5.00
040	17420.03	17420.0	100.00
043	886.43	44.3	5.00
066	387312.35	251753.0	65.00
088	5625.09	5625.1	100.00
092	7849.50	6672.1	85.00
093	200586.23	38861.7	19.37

areas was assumed to be a 50 by 50 ft square. Pit 9 was divided in the following manner:



The corners were marked as shown above to be Northwest (NW), Northeast (NE), Southwest (SW), and Southeast (SE). The location of the individual waste was then found by using the survey coordinates as provided by dBASE III. Table 12 summarizes the data found for each area in Pit 9.

Case 2 was used to determine the metal weight percent since it would represent a worst case scenario. The excavated volume for Pit 9 found in Table 8 is 513,624 ft^3 or 14,544 m^3. This excavated volume was assumed to be equally divided among the 14 areas or 1,038.9 m^3 per area. The average depth of Pit 9 is estimated by Reference 2 to be 12 ft. The calculated volume for an area would then be 850 m^3, which is almost similar to the assumed excavated volume of 1,039 m^3. The metal weight and the total waste volume were calculated for each area. A disposal efficiency was calculated by dividing the total waste volume by the area's excavated volume. The efficiency ranged from a low of 9% for areas 9 and 10 to a high of 44% for areas 7 and 12. Reference 2 estimated the

Table 12. DETAILED METAL CONTENT ANALYSIS FOR PIT 9

Area	Buried Waste Weight (kg)	Metal Weight (kg)	Waste Volume (m3)	Disposal Efficiency	Soil Volume (m3)	Soil Weight (kg)	Total Weight (kg)	Weight Percent Metal
	A	B	C	D=C/1039	E=1039-C	F=E*1500	G=A+F	B/G x 100
1	89,528	35,308.9	281	0.27	758.0	1,136,925	1,226,453	2.88
2	44,346	19,464.6	255	0.25	783.8	1,175,685	1,220,031	1.60
3	82,215	53,802.7	317	0.30	722.3	1,083,375	1,165,590	4.62
4	104,952	61,045.3	391	0.38	648.3	972,480	1,077,432	5.67
5	78,467	58,485.2	445	0.43	593.9	890,820	969,287	6.03
6	72,941	44,608.3	310	0.30	729.2	1,093,785	1,166,726	3.82
7	144,215	102,867.0	461	0.44	577.7	866,595	1,010,810	10.18
8	96,120	85,874.4	312	0.30	726.8	1,090,170	1,186,290	7.24
9	39,650	15,317.7	95	0.09	944.0	1,415,940	1,455,590	1.05
10	20,860	13,559.0	95	0.09	944.4	1,416,585	1,437,445	0.94
11	86,339	26,624.4	223	0.21	815.9	1,223,805	1,310,144	2.03
12	248,542	108,384.9	460	0.44	578.8	868,215	1,116,757	9.71
13	97,945	29,519.1	208	0.20	831.3	1,246,965	1,344,910	2.19
14	166,977	54,743.4	433	0.42	605.9	908,775	1,075,752	5.09
Sum:	1,373,097	709,604.6	4,284		10,260.1	15,390,120	16,763,217	4.23

Excavated Volume (m3):	14,544	(3)
Excavated Volume / 14 (m3):	1,039	
Total Soil Volume (ft3):	362,956	(3)
Total Soil Volume (m3):	10,278	
Total Soil Weight (kg):	15,418,371	(3)
Soil Density (kg/m3):	1,500	

1. Each area is assumed to measure 50 ft x 50 ft.
2. The totals calculated from this table differ from the previous tables due to rounding errors.
3. These were calculated in previous tables.

efficiency to be between 33 and 50%.

The metal mass percentages for each area were calculated as in Table 10 with the metal mass divided by the combined mass of the total waste and soil located in each area. Not surprisingly, the weight percentages were around the 4.0 wt% found previously. These mass percentages ranged from 0.94 wt% to 10.18 wt%. There was also a correlation between the disposal efficiency and the metal mass percent. The areas with the highest disposal efficiencies also had the highest metal mass percentage. Areas 7 and 12 each had 10.2 wt% and 9.7 wt%, respectively, and disposal efficiencies of 44%. The areas with the lowest disposal efficiencies also had the lowest metal mass percentage. These were 0.9 wt% and 1.1 wt% for Areas 9 and 10, respectively, with disposal efficiencies of 9%.

Table 12 seems to verify that the waste in Pit 9 is essentially dispersed evenly and that the 4.0 wt% found previously can be used with confidence. It is expected that this analysis, if applied to the other pits, will essentially follow the same conclusions as those derived in this section.

Finally, Table 13 shows the metal percent of the buried waste for each area in Pit 9. This percentage was calculated by dividing the metal weight by the total waste weight. This percentage ranged from 30% in Area 13 to 89% in Area 8. A distribution of the metal percentage of the buried waste in Pit 9 is shown at the end of this table. Basically, it means that all of the waste buried in each area in Pit 9 contains metal waste.

Table 13. METAL WEIGHT PERCENT OF BURIED WASTE PER AREA IN PIT 9

Area	Metal Weight (kg)	Total Waste Weight (kg)	Percent Metal Of Buried Waste
	A	B	(A/B) * 100
1	35,308.9	89,528	39.44
2	19,464.6	44,346	43.89
3	53,802.7	82,215	65.44
4	61,045.3	104,952	58.16
5	58,485.2	78,467	74.53
6	44,608.3	72,941	61.16
7	102,867.0	144,215	71.33
8	85,874.4	96,120	89.34
9	15,317.7	39,650	38.63
10	13,559.0	20,860	65.00
11	26,624.4	86,339	30.84
12	108,384.9	248,542	43.61
13	29,519.1	97,945	30.14
14	54,743.4	166,977	32.78
TOTAL:	709,604.6	1,373,097	

Percentage of Total Waste < 30% Metal:	0.00
Percentage of Total Waste > 30% & < 40% Metal:	34.99
Percentage of Total Waste > 40% & < 60% Metal:	28.97
Percentage of Total Waste > 60% & < 70% Metal:	12.82
Percentage of Total Waste > 70% & < 80% Metal:	16.22
Percentage of Total Waste > 80% & < 90% Metal:	7.00
Percentage of Total Waste > 90% Metal:	0.00
Total:	100.00

References:

1. RWMIS database transferred to dBASE III.

2. M. P. Plessinger, Volume of Transuranic (TRU) Waste and TRU Contaminated Soil Subject to BWP Retrieval Operations, Engineering Design File BWP-4, March 1988.

3. James O. Low, Annual Technology Assessment and Progress Report for the Buried Transuranic Waste Program at the Idaho National Engineering Laboratory, EGG-2429, December 1985.

4. Thomas L. Clements, Jr., Content Code Assessments For INEL Contact-Handled Stored Transuranic Wastes, WM-F1-82-021, October 1982.